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Title:

STRUCTURE AND METHOD FOR INCREASING PROPRIOCEPTIVE  
DEMANDS ON FOOT, ANKLE AND LOWER LEG

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## STRUCTURE AND METHOD FOR INCREASING PROPRIOCEPTIVE DEMANDS ON FOOT, ANKLE AND LOWER LEG

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a structure and method for increasing the proprioceptive demands on the foot, ankle and lower leg. More particularly, the present invention relates to an exercise surface which includes a plurality of projections extending upward therefrom.

#### 2. Description of the Related Art

Foot, ankle and lower leg sprains are probably the most common injuries in sports. Of these injury classifications, the ankle sprain is the most common type. Ankle sprains are generally classified into grades 1, 2, 3, which correspond to mild, moderate, or severe involvement. They are also classified into three anatomic types: lateral, medial, and syndesmosis. More than 85% of all ankle sprains occur in the lateral ligaments. The surrounding musculature, articular surfaces and the associated neural structures may also be affected. These injuries are known to recur and create prolonged disability. A number of studies have demonstrated that if left unresolved, these injuries will lead to chronic instability, which may affect future athletic performance and put an athlete at greater risk for re-injury.

Treatment of ankle and lower leg sprains may include intervention ranging from surgery and immobilization, to early active and passive ankle mobilization. Early mobilization protocols for many injuries can help the patient return to activity significantly sooner than with immobilization. Rehabilitation of grades 1 and 2 sprains has generally been divided into three phases. Phase 1 rehabilitation is rest, ice, compression, and elevation (RICE) and protected weight bearing as needed. Phase 2 consists of restoring

ankle motion, strength, and proprioception and can begin when the patient can place some weight on the ankle. Phase 3 includes activity-specific drills before return to full activity.

Specific exercises have been designed for recreational athletes and nonathletes, who have neither the time nor the inclination for more intensive supervised rehabilitation.

- 5 Competitive athletes usually engage in a formal physical therapy evaluation and treatment plan incorporating more intensive strengthening and exercises.

Regardless of athletic level, balance exercises are generally used to improve joint stability and proprioception at joints that have been injured. Joint stability occurs when ligaments have healed, muscles have strengthened and neurologic function is restored.

- 10 Proprioception is the body's ability to know where it is in space. For instance, if a person closes his eyes and moves his arm, proprioceptors are stimulated in the shoulder muscles, tendons, ligaments and joint surfaces, and the brain knows where the arm is in space, even though the person can not see. Sensory nerve cells, called proprioceptors, allow the nervous system to detect pressure, tension in tendons, direction of movement and position
- 15 of joints to help maintain balance during various forms of movement. When the nerve cells are injured, such as in a sprain, the nerve pathways must be retrained to quickly conduct information from the injured joint to the spinal cord and brain.

- Balance board activities are a very common form of proprioceptive training used to rehabilitate ankle, knee and other lower extremity injuries. Other classes of exercises
- 20 include strength training to stabilize the ankle and stretching to increase activation of the proprioceptors. The balance boards facilitate certain improvements in joint stability and a level of reduction in re-injury rates. Balance boards work by re-training the proprioceptors to recognize the position of the ankle or knee. Repetitive use of balance boards stimulates neurological pathways from the injured joint to the brain. The result is decreased latency in
- 25 neurologic conduction in pathways to the brain, improving function at the foot, ankle and lower extremity in general.

The goal of any rehabilitation program is to safely return an individual to his or her sport or activity of daily living with as little risk of re-injury as possible. Generally, rehabilitation exercises performed by non-athletes, recreational athletes and competitive athletes are performed on flat and level surfaces. Flat and level surfaces are not the only types of terrain on which an athlete competes, especially those who compete in sports played on natural or synthetic turf surfaces. In addition, individuals encounter many uneven and unexpected obstacles on sidewalks, in parks or in carpeted homes. Therefore, proprioceptive training on flat and level surfaces is only effective to a certain degree in an individual's rehabilitation and ease of return to competition or activity of daily living with minimal risk of re-injury.

#### BRIEF SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an apparatus and method which increases the proprioceptive demands on the foot, ankle and lower leg and which mimics the terrain normally encountered by athletes and individuals so that effectiveness of training can be improved and rehabilitation time decreased.

In accordance with one preferred embodiment of the present invention, there is provided an exercise surface which includes a base having a plurality of projections extending upward from the base and at least one removable overlay. The removable overlays include apertures that correspond to the plurality of projections. Preferably, there are three overlays of different thickness.

Rehabilitation training on the exercise surface of the present invention generally provides stimuli to the foot/ankle complex, knee, hip joints and lower limbs in general, as well as the vestibular components of balance. Sequential removal of the overlays during rehabilitation training provides for a progressive increase in the perturbations to the above-mentioned structures.

In accordance with a second embodiment of the present invention, different exercise surfaces are provided in a set of at least two exercise mats. The exercise surfaces in the set of mats preferably differ from each other in the heights of the plurality of projections, the modulus of elasticity of the plurality of projections, and/or in the surface treatment. During rehabilitation training, the healthcare professional can progress the athlete through the different mats in the set, thereby changing the proprioceptive demands placed on the foot, ankle and lower leg.

In accordance with a third embodiment of the present invention, different exercise surfaces are provided in a set of at least two belts adapted for use on a treadmill. Preferably, the set of belts are provided as a belt kit. The exercise surfaces in the set of treadmill belts preferably differ from each other in the heights of the plurality of projections, the modulus of elasticity of the plurality of projections, and/or in the surface treatment. During rehabilitation training, the healthcare professional progresses the athlete through the different belts in the set, thereby changing the proprioceptive demands placed on the foot, ankle and lower leg.

In summary, since individuals encounter many uneven and unexpected obstacles on a field of play, on sidewalks, in parks or in carpeted homes, these types of perturbations are incorporated into the individual's rehabilitation program and training with the apparatus and methods of the present invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred, it being understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown. The features and advantages of the present invention will become apparent from the following description of the invention that refers to the accompanying drawings, in which:

FIGS. 1A and 1B show an exercise surface in accordance with a first embodiment of the present invention;

FIG. 2 is a cross-sectional view of an exercise surface in accordance with the first embodiment of the present invention;

5           FIGS. 3A and 3B are perspective views of a second embodiment of the present invention; and

FIGS. 4A and 4B are perspective views of a third embodiment of the exercise surface of the present invention adapted for use on a treadmill.

#### DETAILED DESCRIPTION OF THE INVENTION

10           Referring now to the drawings, Figs. 1A and 1B show a first embodiment of the exercise surface 1 of the present invention. The exercise surface 1 includes a base 2 having a plurality of projections 4 extending upward from the base 2 and at least one removable overlay 6. The removable overlay 6 includes apertures 8 that correspond to the plurality of projections 4. The plurality of projections 4 and corresponding apertures 8 in the overlay 6  
15           can be either randomly spaced or spaced in a repeating pattern.

          Preferably, as shown in Fig. 2, the exercise surface 1 is provided with three removable overlays 9, 10 and 11 having different respective thicknesses. Each of the overlays 9, 10 and 11 have apertures 12, 13 and 14 that respectively correspond to the plurality of projections 4. In the most preferred embodiment, the plurality of projections 4  
20           have a height of two inches and the three removable overlays 9, 10 and 11 have respective thicknesses of 1/4 inch, 1/2 inch and 1 inch. These dimensions are merely exemplary and other various projection heights and overlay thicknesses may be used as desired by the healthcare professional administering the rehabilitation program.

As shown in Fig. 2, the three removable overlays 9, 10 and 11 are preferably placed over the base 2 such that the 1/4 inch overlay 9 is at the top, the 1/2 inch overlay 10 is in the middle and the 1 inch overlay 12 is at the bottom and closest to the base 2. The removable overlays 9, 10 and 11 are designed so that the height of the projection 4 can easily be varied by sequentially removing each of the overlays as rehabilitation of the athlete progresses. For example, with the arrangement shown in Fig. 2, rehabilitation can begin with an exercise surface having a projection of 1/4 inch height (all three overlays 9, 10 and 11 are used over the base), and then progress through an exercise surface having projections of 1/2 inch (1/4 inch overlay 9 is removed), 1 inch (1/4 inch overlay 9 and 1/2 inch overlay 10 are removed), and then 2 inches (all three overlays 9, 10 and 11 are removed). This sequential removal of the overlays 9, 10 and 11 during rehabilitation training provides for a progressive increase in the perturbations to the foot/ankle complex, knee, hip joints and lower limbs in general, as well as the vestibular components of balance.

In addition to providing the overlays, the plurality of projections 4 can be formed having different heights between each other. The use of projections 4 having different heights on a single exercise surface increases the proprioceptive demands placed on the foot, ankle and lower leg during rehabilitation by providing an exercise surface having a varying contour with each step.

Further, the projections 4 can be formed having the same or similar modulus of elasticity, or a differing modulus of elasticity on a single exercise surface. The use of projections having different modulus of elasticity will further increase the proprioceptive demands during rehabilitation by providing an exercise surface having varying a “rebound” with each step.

As a further modification, the plurality of projections 4 can be formed with both varying heights and varying modulus of elasticity in a single exercise surface so as to further increase the proprioceptive demands during rehabilitation. The exercise surface can also be

provided with a surface treatment which mimics the terrain on which the athlete competes, such as for example an artificial turf, so as to provide further proprioceptive training.

As an option to providing overlays, a second embodiment of the present invention provides a set of exercise mats 20 and 22, such as those shown in Figs. 3A and 3B, wherein each of the exercise mats 20 and 22 in the set have a different exercise surface 23. The exercise surfaces 23 in the set of mats preferably differ from each other in at least one of the heights of the plurality of projections, the modulus of elasticity of the plurality of projections, and/or in the surface treatment which mimics the terrain on which the athlete competes, such as for example an artificial turf. Although only two exercise mats 20 and 22 are shown in Figs. 3A and 3B, it will be readily apparent that more than two different types of mats can be provided.

During rehabilitation training, the healthcare professional can progress the athlete through the different mats in the set, thereby changing the proprioceptive demands placed on the foot, ankle and lower leg.

Figs. 4A and 4B show a third embodiment of the exercise surface of the present invention. In the third embodiment, the exercise surface is adapted for use as a belt kit for a treadmill. The belt kit includes at least two belts 30 and 32 each having an exercise surface 33. Each exercise surface 33 includes a plurality of projections 34 extending upward therefrom, and each of the at least two belts 30 and 32 have a different exercise surface 33. The exercise surfaces 33 are preferably different from each other in at least one of the heights of the plurality of projections, the modulus of elasticity of the plurality of projections, and/or in the surface treatment which mimics the terrain on which the athlete competes, such as for example an artificial turf as shown in Fig. 4B.

Preferably, the treadmill belts have staggered irregular projections which range in height from 1/4 inch to 1 inch. Although only two belts are shown in Figs. 4A and 4B,



it will be readily apparent that more than two different types of belts can be provided in the belt kit.

When the exercise surface of the present invention is provided on a treadmill, the athlete is required to produce a higher energy output to run than that required of a standard flat treadmill belt. The belts in the belt kit are designed to either be interchanged on a single treadmill, or placed on individual dedicated treadmills having the different belts. Thus, during rehabilitation training, the healthcare professional progresses the athlete through the different belts in the set, thereby changing the proprioceptive demands placed on the foot, ankle and lower leg.

The balance mats and overlays described herein are preferably formed of a resilient material, such as a foamed rubber, or any other analogous resilient material. The treadmill belts are preferably formed from standard treadmill belt material and include a laminated layer of projections. Other materials and methods for forming the various embodiments of the present invention will be readily apparent to one skilled in the art.

Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.